



Radial Inclination and Palmar tilt as Risk Factors for Kienböck's Disease

Authors

Ajaz Ahmad Bhat¹, Zubair Ringshaw², Suhail Wani³

¹Medical Officer, Department of Health, J&K

^{2,3}Postgraduate Scholars, Orthopaedic Department, GMC Srinagar

Abstract

Radial inclination angle (RIA) and palmar tilt (PT) of distal articular surface of radius, are anatomical factors that influence force transmission across the wrist and load transfer to the lunate. The purpose of this study is to evaluate the relationship between these parameters and Kienböck's disease.

We measured and compared RIA and PT in standard posteroanterior and lateral wrist x-rays of 50 patients with Kienböck's disease and 55 controls. The mean RIA was 26.5° in Kienböck's disease patients and 24.0° in the control group ($P = 0.002$). The mean PT was 12.5° and 10.4° for patients and controls, respectively ($P = 0.005$). All of these differences were statistically significant. We concluded that there is an etiological association between higher degrees of RIA and PT with Kienböck's disease.

Introduction

In 1910, Robert Kienböck, a Viennese radiologist, reported a series of 16 cases of traumatic malacia of the lunate¹. Although others had described similar anatomic findings in cadaveric specimens, Kienböck's was the first clinical report of osteonecrosis of the lunate. Controversy still exists about the etiology of the disease despite numerous investigations. Negative ulnar variance, first identified as a factor by Hulth² in 1928, was present in 78% of his patients with Kienböck's disease, but in only 23% of the general population. Hulth suggested that a short distal ulna led to increased force transmission across the radiolunate articulation, contributing to an increased risk of osteonecrosis. However, D'Hoore et al³ found no statistically significant difference in ulnar variance when they compared 125 normal wrists with 52 wrists in patients with Kienböck's disease. Several investigators from

Japan^{4,5} have noted that negative ulnar variance occurs with equal frequency in patients with Kienböck's disease and in the general population. Among other various anatomical features that were postulated as the risk factors for lunatomalacia^{5,6}, those that are related to the biomechanics of force transmission across the wrist and load transfer to the lunate, are more challenging and thus more attractive⁷. As per the biomechanical analyses, radial inclination angle (RIA) and palmar tilt (PT) of distal radial articular surface, have apparent impact on the load transfer to the lunate^{7,8}. A flattened radial inclination may predispose to Kienböck's disease^{5,9}. Nevertheless, different and even paradoxical results were reported about the relationship between these parameters and Kienböck's disease⁹⁻¹³. The purpose of this study was to determine the RIA and PT as possible anatomical risk factors for Kienböck's disease

Patients and Methods

This study was conducted in the Department of Orthopaedics, Government Medical College, Srinagar between August 2016 and January 2019. Wrist radiographs of patients diagnosed with Kienböck's disease, based on typical x-ray and magnetic resonance imaging (Figure A and B). The diagnostic criteria laid by the Lichtman¹⁴ were used to classify patients into different stages:-

Stage I: linear or compression fracture of lunate in plain radiograph or low signal intensity on MRI in the absence of x-ray changes.

Stage II: sclerosis and density changes.

Stage IIIA: collapse or fragmentation of lunate without carpal collapse.

Stage IIIB: Stage IIIA with carpal collapse.

Stage IV: All the findings of stage III plus generalized degenerative changes within the carpus.

There were no stage I patients diagnosed during this period and those patients with stage IV disease were excluded from the study to avoid interference of osteoarthritic changes with measurements.

The posteroanterior wrist x-ray was considered acceptable when the cortical margin of the extensor carpi ulnaris groove was radial to the ulnar styloid¹⁵, and this was true for the lateral view when the palmar aspect of pisiform located between the capitate and the volar surface of distal scaphoid¹⁶.

Wrist x-rays of 50 patients (40 males, 10 females) between 18 to 45 years (mean age, 26.4 years), were included in this study. Of these patients, 13 were stage II, 25 stage IIIA, and 12 stage IIIB. Majority of patients were in stage IIIA.

The control group consisted of radiographs from the uninjured wrist of 55 wrist trauma patients (40 males and 15 females between 16 to 55 years; mean 28.2), that were taken in standard manner described by Palmer and colleagues¹⁷. History about any old trauma, pain of this wrist or generalized bone disorder were taken from control group. There was no significant difference

between patients and controls according to age ($P = 0.21$).

Radiologic parameters that we evaluated in this study were RIA and PT. Angulation of distal articular surface of radius was considered in relation to the long axis of bone in posteroanterior view of wrist to measure the RIA, PT was determined by a line connecting the distal points of dorsal and volar rims of radius, in relation to another line perpendicular to the long axis of bone in lateral view of wrist¹⁸.



Figure. (A) A posteroanterior wrist radiograph displaying sclerosis and fragmentation of the lunate. (B) The corresponding T1-weighted coronal image MRI shows a low signal intensity necrotic lunate.

Results

Based on our measurements, the mean RIA was 26.5 in Kienböck's disease patients (range, 20°-34°), and 24.0° in controls (range, 12°-30°). This difference was statistically significant ($P = 0.002$). This study has also revealed that the mean PT was 12.5° (range, 6°-20°) and 10.4 (range, 0°-15°) in Kienböck's disease patients and controls, respectively. This difference was also statistically significant ($P = .005$).

Discussion

Mir and colleagues¹⁹ showed steeper radial inclination in patients with Kienböck's disease. Watanabe and colleagues,⁹ as well as Tsumura and colleagues,^{10,11} also showed a direct relationship between radial inclination and force transmission to the lunate in biomechanical studies; these findings were supported by several clinical studies^{7,20-22}. However, Mirabello and colleagues⁶, and Tsuge and Nakamura⁵ demonstrated that RIA is flatter in patients with Kienböck's disease. Experimental studies also

showed increased lunate strain by decreasing radial inclination, but no clinical correlation was demonstrated^{11,12}. Davood Jafari et al²³, demonstrated that RIA was steeper in Kienböck's patients as compared to controls in their study which suggests higher RIA may be a risk factor for Kienböck's disease. In our study, RIA was significantly steeper in patients with Kienböck's disease, compared with controls. This suggests that there may be an etiological association between high RIA and Kienböck's disease.

Lamas and colleagues⁷ proposed that lunate is under excess load, especially in dorsal pole due to palmar facing articular surface of radius, and suggested that reduction of PT decompressed the lunate in sagittal plane and increased radiolunate space. Nevertheless, according to Tsuge and Nakamura,⁵ PT was not markedly higher in lunatomalacia. Based on the results of our study, PT of distal articular surface of radius was markedly higher in Kienböck's patients, compared with controls. Greater PT may be a risk factor for this disease.

Conclusion

We conclude that steeper RIA and PT may be an etiological factor for Kienböck's disease.

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